Caissons and Cofferdams

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Overview:

The successful construction and operation of bridge caissons (to install bridge piers in water) was critical to the successful construction of bridges both worldwide and in the United States. The construction and the operation of the caissons brought significant scientific challenges, made very real by the mysterious deaths caused by "caisson disease". Regarding caissons and (related) cofferdams, 'caisson' literally means 'box'; whereas a cofferdam is removed after the structure is completed, a caisson remains in place and forms an integral part of the structure. During the construction period, the caisson functions as a cofferdam. The bridge piers extended through unstable layers (such as sand, loose rock, and mud) down to the bedrock during the bridge construction. This final portion of the lesson plan focuses on the study of geology.

Objectives

1. The learner will be able to compare and contrast the similarities and differences between both caissons and cofferdams.
2. The learner will be able to describe the challenges of building bridges that include piers that extend down to the bedrock in a body of water.
3. The learner will be able to define a caisson after analyzing photographs of the construction of the Brooklyn Bridge from the Library of Congress.

Time Required: (2) standard 45-minute class periods

Recommended Grade Range: Suggested grades 4-6

Subject / Sub-Subject

This lesson plan could be taught in a STEM course (in the areas of Inventions, Geology, or Properties of Matter especially when related to Pressure) or in Social Studies when studying the Industrial Revolution.

Standards

SS4E1(f): Give examples of technological advancements and their impact on business productivity during the development of the United States (such as the steamboat, the steam locomotive, and the telegraph (from the Georgia Performance Standards for 4th grade Social Studies).

S6E5: Students will investigate the scientific view of how the earth's surface is formed (from the Georgia Performance Standards for 6th grade Science).

PREPARATION

Materials

Analyzing Photographs and Prints Analysis Tool Worksheet from the Library of Congress: http://www.loc.gov/teachers/usingprimarysources/resources/Analyzing_Photographs_and_Prints.pdf

For the extension activity, the following is needed for each group of students:

- large aluminum casserole pan
- water
- 40 popsicle sticks
- plastic wrap
- turkey baster
- large rubber bands
- plastic wrap
- pebbles (about ½ cup)
- clay (about 2 cups)

Resources

The following Library of Congress primary sources will be used in this lesson:

1. HAER NY,31-NEYO,90- (sheet 1 of 1) - Brooklyn Bridge, Spanning East River between Park Row, Manhattan and Sands Street, Brooklyn, New York County, NY; http://www.loc.gov/pictures/item/ny1234.sheet.00001a/; No author (No known restrictions on images made by the U.S. Government).
2. Inside views of the East River Bridge caisson, Brooklyn, N.Y. / from sketches by our special artist; https://www.loc.gov/item/99472666/; No Author (No known restrictions on publication).
3. The TVA Fort Loudoun Dam construction cofferdam at https://www.loc.gov/resource/fsa.8b04453/; Palmer, Alfred T., photographer. United States. Office of War Information (no known restrictions on images made by the U.S. Government).

PROCEDURE

1. The teacher will begin the lesson by stating "Do you ever think about the advantages that bridges provide our society?" Please imagine life in our city/town without the _____ bridge. What would that be like? Think about that for a minute and record in your journal your thoughts. After a minute, the teacher will ask students to pair with a partner (think-pair-share strategy) and share their writings. The partners will already be pre-determined prior to the start of the lesson.

2. The teacher will then ask the students to open the Brooklyn Bridge primary source. They should search the document to locate answers to the following questions: How far below the waterline does the Manhattan caisson extend? How far below the waterline does the Brooklyn caisson extend? What other information can you find regarding the caissons? What were some of the unfortunate consequences of building infrastructure during the Industrial revolution (**Answer:** loss of human life- often poor immigrants).
3. Using the Analyzing Photographs and Prints Tool Worksheet, the students should study the primary source documents "Inside views of the East River Bridge caisson" at https://www.loc.gov/item/99472666/ and the TVA Fort Loudoun Dam construction cofferdam at https://www.loc.gov/resource/fsa.8b04453/ . The students can think-pair-share and answer the question "Based on the two primary sources, how are caissons and cofferdams similar and different?" Again, as in the above activity, the students will work with a pre-determined partner. To answer this question, the students may be allowed to conduct Internet-based research on a classroom computer.
4. For the inquiry activity below, the following must be constructed for each group: About two cups of clay should be spread out in an aluminum casserole pan to cover about 9 square inches (3"x 3"). A thin layer of pebbles is then placed in the center area of the clay (though there is a clear layer of clay on the periphery that is pebble-free). The clay on the periphery needs to be sufficiently thick to allow the Popsicle sticks to be free standing when pushed down to the "bedrock". All of that is covered to a depth of 2" in water.

The students will then use the phases of the inquiry cycle below to build and operate a miniature cofferdam.

Inquiry Includes:

- ***Connect*** – From the previous research, what are the issues and challenges for students in building a cofferdam?
- ***Wonder*** – Pre-determined heterogeneous student groups of three will be provided the following materials: 40 Popsicle sticks, plastic wrap, turkey baster, and large rubber bands. The students are then presented with the following challenge: Given these materials, how can your group create a cofferdam that can be used successfully to remove most or all of the water inside it to allow removal of the pebbles? The students should create a hypothesis or prediction in their journal and then share with partners. Each group will spend 10 minutes to create and sketch a cofferdam design. The first lesson will end here and the teacher will state "tomorrow we'll carry out your designs". **Second lesson:** The student groups will present to the class their designs and then class members will provide constructive feedback. At that point, the student groups will carry out their designs.
- ***Investigate*** – The student groups will proceed to construct their cofferdams for 30 minutes.
- ***Construct*** – The student groups will reflect on previous research and relative success in building the cofferdam in their journals.

- ***Express*** – The student groups will present to the class their findings on what worked and didn't work in the design and construction phase.
- ***Reflect*** – The students will reflect on their own learning and ask at least two new questions about caissons and/or cofferdams in their journal. The students will also record their questions on Post-It Notes on the class dry erase board that is located at the front of the classroom. The students will then collaboratively group the notes by ideas and/or themes.

Extensions

The lesson can be modified to be more cookbook-oriented. Teachers interested in that should refer to the section of the children's book *Bridges! Amazing Structures to Design, Build, & Test* (1999) titled "Build a Cofferdam".

Evaluation

The evaluation of student learning will be completed by a teacher analysis of classroom journal responses based on the conclusion of the lesson.